The Effect of Cosecure on the conception rate and trace element status of dairy cattle

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Introduction

Dietary deficiencies in single or multiple trace elements can have profound effects on the reproductive performance of dairy cattle. Infertility, decreased conception rate, anoestrus and delayed onset of puberty in cattle has previously been reported to be associated with clinical copper deficiency and high dietary molybdenum intakes (Munro, 1957, Phillippo *et al.*, 1985; Phillippo *et al.*, 1987). The aetiology of clinical copper deficiency in ruminants has been shown to involve a complex interaction of copper with molybdenum and sulphur and with iron and sulphur compounds formed in the anaerobic conditions present in the rumen. Molybdenum and sulphur form a series of di-, tri- and tetra-thiomolybdates which bind to copper to form copper thiomolybdate which is not absorbed by the animal and is excreted in the faeces. However, if there is insufficient dietary copper available in the rumen, the thiomolybdates are absorbed as their ammonium salts through the rumen wall into the blood. The copper-iron-sulphur complex is also not absorbed by the animal. High levels of dietary iron supplemented to calves resulted in decreased plasma and liver copper concentrations, but did not induce clinical copper deficiency (Humphries *et al.*, 1983). However, when molybdenum was supplemented to the calves, similar decreases in plasma and liver concentrations were recorded along with clinical signs of copper deficiency. Therefore, clinical copper deficiency is now known to be due to the systemic effects of absorbed thiomolybdates on copper metabolism and not to a reduction in the copper available for absorption. Levels of molybdenum in the herbage are influenced by soil pH, soil drainage and grass species. The iron levels of herbage are by themselves unlikely to significantly reduce copper availability. However, soil ingestion can represent a significant iron source in ruminants and it has been estimated that cattle can consume about 100 g soil /kg DM of herbage intake (Burridge *et al.*, 1983). Cattle in the dairy herd at the University of Leeds farm have previously suffered from low conception rates and anoestrus and some have also shown visible signs of clinical copper deficiency (spectacles and poor coat colour). A trial was set up on this farm to test the effects of trace element supplementation by mean of a slow release soluble-glass bolus containing copper, cobalt and selenium on the fertility and trace element status of cattle.

Materials and Methods

Sixty Holstein Friesian dairy cattle in early lactation were allocated to two treatment groups by restricted randomisation of plasma copper concentrations. Thirty cattle were bolused with two soluble-glass copper, cobalt and selenium boluses (Cosecure, Telsol Ltd.) on day 0 and day 169 while the remaining 30 cattle were unbolused (Controls). The cattle were grazed at the University of Leeds farm prior to the start of the trial until housing on day 165. Herbage samples were obtained throughout the grazing period and analysed for mineral content by Inductive Couple plasma (ICP) and atomic absorption and soil and faeces titanium levels were determined to estimate soil ingestion (Burridge *et al.*, 1983). At housing, the cattle were offered grass silage *ad libitum* and concentrate diets were fed to yield. Blood samples were collected by jugular venepuncture at day 0 (pre-bolusing) and on days 30, 78, 135, 169, 205, 146 and 280. Trace element status was determined by the methods outlined by Mackenzie *et al.* (1996b). The copper parameters measured were: 1. plasma copper (Pl-Cu) by atomic absorption spectrophotometry, 2. TCA-soluble copper (TCA-Cu) was determined as the soluble copper in 10% trichloroacetic acid as measured by atomic absorption, 3. erythrocyte superoxide dismutase (SOD) and serum caeruloplasmin (CP) activities were measured on a Cobas-Mira (Roche) and 4. copper status was determined by the ratio of caeruloplasmin activity to plasma copper concentration (CP/Pl-Cu) to give an indication of the biologically available copper as described by Mackenzie *et al.* (1996a). Selenium status was measured by the activity of the erythrocyte seleno-enzyme glutathione peroxidase (GSHPx) on the Cobas-Mira. Detailed records of artificial inseminations and fertility of the cattle were maintained. Statistical analysis of the results was by Analysis of Variance (GLM).

Results

The herbage molybdenum levels ranged from 2.3 to 3.1 mg/kg DM and copper levels from 9.1 to 11.3 mg/kg DM during the time the cattle were grazing. The molybdenum level of the silage was 1.8 mg/kg DM and the copper level was 13.8 mg/kg DM. Soil ingestion was calculated to range from 0.6 to 0.8 kg DM/day which supplied 900-1100 mg iron per day.

Cattle bolused with Cosecure had significantly fewer inseminations to confirmed conception compared with the control animals ($p<0.01$) (Table 1). They also had a significantly shorter calving interval ($p<0.05$) compared with the control cattle. There was no significant effect of treatment on the calving to conception interval.

Table 1. Effect of Bolusing on the Fertility of Cattle.

	Control	Cosecure	SEmean	Sig
Number of Insemination	2.5	1.7	0.16	$p<0.01$
Calving Interval (days)	397	372	9.2	$p<0.05$
Calving to Conception (days)	117	95	9.3	NS

The blood copper parameters measured are shown in Table 2. There was an overall trend for the bolused cattle to have a higher copper status compared with the control cattle while they were at pasture. However, after housing, there was no significant difference in the copper status between the groups. Bolused cattle had significantly greater plasma copper TCA-copper concentrations on days 30, 78 and 135 compared with the control animals ($p<0.001$). Bolused animals had significantly greater SOD activities on days 78 and 135 ($p<0.05$ and $p<0.001$ respectively) and greater caeruloplasmin concentrations on day 78 ($p<0.05$) compared with the controls. There was no effect of bolusing on the caeruloplasmin to plasma copper ratio at any time during this trial. The bolused cattle had significantly greater erythrocyte GSHPx activities on day 246 compared with the controls ($p<0.05$). However, on all other days, there was no significant effect (Table 3).

Table 2. Effect of Bolusing on the Copper Status of Cattle.

	Day	Control	Cosecure	SEmean	Sig
Plasma Copper (μmol/litre)	0	13.8	13.9	0.22	NS
	30	13.4	14.0	0.14	$p<0.01$
	78	12.7	14.7	0.18	$p<0.001$
	135	13.3	14.9	0.18	$p<0.001$
	169	14.0	14.2	0.13	NS
	205	14.3	14.2	0.19	NS
	246	14.7	14.4	0.35	NS
	280	14.0	14.5	0.17	NS
TCA-Soluble Copper (μmol/litre)	0	12.5	12.7	0.18	NS
	30	12.2	14.0	0.15	$p<0.001$
	78	11.0	13.7	0.15	$p<0.001$
	135	12.2	14.1	0.20	$p<0.001$
	169	13.3	13.6	0.11	NS
	205	13.5	13.6	0.18	NS
	246	13.8	13.6	0.33	NS
	280	13.1	13.5	0.17	NS

Table 2 (Cont). Effect of Bolusing on the Copper Status of Cattle.

	Day	Control	Cosecure	SEmean	Sig
SOD Activity (Units/g Hb)	0	3192	3119	47.3	NS
	30	3058	3186	41.2	NS
	78	3222	3528	80.0	$p<0.05$
	135	3090	3475	63.3	$p<0.001$
	169	3291	3323	45.8	NS
	205	3653	3851	74.1	NS
	246	3635	3747	53.3	NS
	280	3261	3412	52.4	NS
Caeruloplasmin (mg/dl)	0	22.6	23.2	0.38	NS
	30	20.9	21.2	0.79	NS
	78	19.5	22.3	0.70	$p<0.05$
	135	21.2	23.9	0.99	NS
	169	23.3	24.2	1.02	NS
	205	25.2	24.4	0.80	NS
	246	25.4	26.7	1.00	NS
	280	22.6	24.6	0.53	NS
CP:Pl-Cu Ratio	0	1.65	1.68	0.037	NS
	30	1.56	1.51	0.057	NS
	78	1.52	1.52	0.044	NS
	135	1.59	1.59	0.060	NS
	169	1.66	1.70	0.068	NS
	205	1.77	1.73	0.061	NS
	246	1.71	1.88	0.059	NS
	280	1.62	1.70	0.047	NS

Table 3. Effect of Bolusing on the Erythrocyte Glutathione Peroxidase Activity of Cattle.

	Day	Control	Cosecure	SEmean	Sig
GSHPx Activity (Units/ml PCV)	0	97	97	3.2	NS
	30	104	112	2.9	NS
	78	111	118	2.3	NS
	135	126	131	2.7	NS
	169	138	136	4.5	NS
	205	136	143	3.8	NS
	246	134	145	3.1	$p<0.05$
	280	111	119	3.8	NS

Discussion

These results show that poor conception rates in dairy cattle resulting from high molybdenum intakes can be counteracted by a slow release copper, cobalt and selenium soluble-glass bolus. The author attribute this effect to be a copper response and not a response to selenium and cobalt. Although the bolused cattle had an elevated GSHPx activity on day 246, there was no significant effect at any other sampling time and both groups of cattle had a more than an adequate selenium status (>40 Units/ml PCV) and would therefore be unlikely to show fertility responses to selenium. Similarly although cobalt status in cattle can not be assessed (Carlos *et al.*, 1986) the level of cobalt supply was adequate. The plasma copper concentrations in both treatment groups were all in the normal range throughout the duration of the trail (>12.0 μmol/litre) and would not have been diagnosed as requiring copper supplementation on these criteria. However, Mackenzie *et al.* (1996b) highlighted the inaccuracy of using plasma copper concentrations as a method for determining copper status. The present data show that cattle grazing herbage containing 3.1 mg molybdenum /kg DM and 9.1 mg copper /kg DM and consuming soil (a source of Fe) that are not supplemented with copper can suffer from poor conception rates and increased calving intervals. The effect of the bolus on the copper status of the cattle was evident during the grazing period but not when housed. This may be due to the molybdenum content of the grass silage and concentrate diet being much lower than that present in the herbage. This would reduce the thiomolybdate challenge to the animals, and would also have lessen any deleterious effect on the animals fertility. The net effect of the Cosecure treatment was to increase the fertility of the cattle compared with the controls despite normal copper and selenium status in both groups. The copper released into the rumen from the bolus prevents the thiomolybdate being absorbed and prevents any clinical deficiencies.

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